Sandia National Laboratories

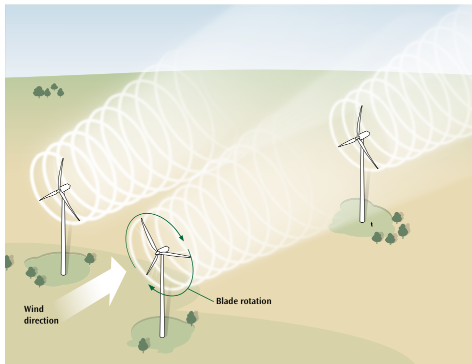
Energy, Climate, & Infrastructure Security

Scaled Wind Farm Technology Facility

The Scaled WInd Farm Technology (SWiFT) Facility, hosted at Texas Tech University, enables rapid, cost-efficient testing and development of transformative wind energy technology.

Vision

To enhance the nation's security and prosperity through sustainable, transformative approaches to our most challenging energy, climate, and infrastructure problems.



Turbine–turbine interaction schematic with wakes denoted by white helices and white fog.

SWiFT performs accredited research testing for both collaborative and highly proprietary projects with industrial, governmental, and academic partners.

A flexible Memorandum of Understanding, signed by all partners—Sandia, Vestas, Texas Tech Univ. Wind Science and Engineering Center at Reese Technology Center and Group NIRE, a renewable energy development company—allows site use for collaborative and proprietary research, depending on research needs.

SWiFT's primary research objectives are to

- reduce power loss and damage caused by turbine–turbine interaction through study of complex wake flows through study of complex wake flows (see figure);
- enhance wind farm energy capture and damage-mitigation potential of advanced rotors;
- improve the validity of aerodynamic, aero-elastic, and aeroacoustic simulations used to develop innovative technologies; and
- improve wind plant reliability with new technology.

Test-Bed Wind Turbines Allow Facility Flexibility While Providing Reliable Data in Many Regimes

The facility is comprised of three heavily instrumented and modified variable-speed variable-pitch Vestas V27 turbines and two 60 m anemometer towers, with the first two turbines spaced three diameters apart, perpendicular to the oncoming wind, and the third turbine five diameters downwind (the turbines form a three-, five-, six-diameter-length triangle).

Two turbines are funded by the DOE's Office of Energy Efficiency and Renewable Energy. The third turbine was installed by Vestas R&D of Houston, Texas. Vestas invested in the site to develop a technology accelerator to rapidly and cost-effectively facilitate marketplace innovation. Vestas is also interested in improving wind plant performance, rather than concentrating on a single turbine's output.

The V27 turbine was chosen as the test bed due to its proven history of high reliability. It will be capable of full variable-speed variable-pitch operation with rotational speeds ranging from 0 to 55 rpm, rotor blades of 9 to 15 meter lengths, and a maximum power rating of 300 kW.

These research-scale machines have a Reynolds Number of 2×10^6 and maximum tip-speeds of 80 meters per second which is intended to make the

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results directly scalable to much larger turbines. In comparison to larger production turbines, at the research-scale, blades and molds are approximately five percent of the cost, cranes are two percent of the cost, crane scheduling is reduced from months-ahead to days-ahead, and failure risk is substantially less.


The SWIFT control building.

The site has the potential to add seven additional research-scale wind turbines in the future.

Control Building

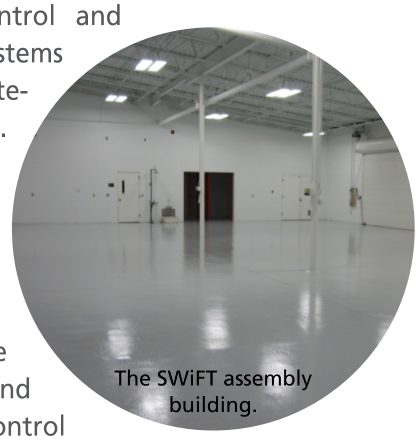
A control building, located at the facility's northwest corner, contains 640 square feet of computing space for wind-turbine control, including two offices for proprietary work and an electronic troubleshooting shop. Each turbine and anemometer has an individual fiber-optic bundle connection directly connected to this building—allowing for a tremendous data transfer capability and flexible site network reconfiguration.

Assembly Building

For experimental preparation of rotors and other components, a 7500 square foot, environmentally controlled high-bay assembly area with an additional 2000 square feet of office space is located nearby. The assembly area has been upgraded with new lighting, painting, and HVAC to facilitate the most demanding and sensitive instrumentation experimental calibration. Additionally, a machining area including a lathe, multiple mills, drill press, welders, and a full complement of tooling is available to produce unique and on-demand parts.

Full Instrumentation for Detailed Data Acquisition

The turbines are heavily instrumented with state-of-the-art control and data-acquisition systems featuring GPS-based, site-wide time synchronization. The site instrumentation provides hundreds of channels of structural and aerodynamic data to fully understand the instantaneous state of the rotor, wind turbines, and wind farm for advanced control strategies, such as rotor-based active aerodynamic load control.


The SWiFT assembly building.

In addition, two 60-meter anemometer towers are located 2.5 rotor diameters directly upwind of the leading turbines that will have research-grade 3-D sonic anemometers to measure the inflow at six levels, including one that is a blade length above the rotor and a companion set of three certification quality cup anemometers to meet future IEC standards. Additional site facilities include the Texas Tech Univ. 200-meter tall anemometer tower.

WiSE Advantages

SWiFT also uses the state-of-the-art atmospheric observation facility at Texas Tech University's Wind Science and Engineering Research Center (WiSE), including the 67-station West Texas Mesonet, a regional SOnic Detection and Ranging (SODAR) network, and the mobile research laboratory.

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